GRADE 12 DIPLOMA EXAMINATION

Physics 30

June 1991

Alberta
EDUCATION

GRADE 12 DIPLOMA EXAMINATION
PHYSICS 30

DESCRIPTION

Time: 2½ hours

Total possible marks: 70

This is a **closed-book** examination consisting of **two** parts:

PART A has 49 multiple-choice questions each with a value of one mark.

PART B has four written-response questions for a total of 21 marks.

A physics data booklet is provided for your reference. **You will require an accurate ruler to answer question 1 of Part B.** If you do not have one, there is a ruler provided on **each** of the tear-out pages.

NOTE: The perforated pages at the back of this booklet may be torn out and used for your rough work. **No marks** will be given for work done on the tear-out pages.

GENERAL INSTRUCTIONS

Fill in the information required on the answer sheet and the examination booklet as directed by the examiner.

You are expected to provide your own scientific calculator.

Carefully read the instructions for each part before proceeding.

DO NOT FOLD EITHER THE ANSWER SHEET OR THE EXAMINATION BOOKLET.

The presiding examiner will collect your answer sheet and examination booklet and send them to Alberta Education.

JUNE 1991

PART A

INSTRUCTIONS

In this part of the examination, there are 49 multiple-choice questions each with a value of one mark. All numbers used in the questions are to be considered as the result of a measurement.

Read each question carefully and decide which of the choices **best** completes the statement or answers the question. Locate that question number on the separate answer sheet provided and fill in the space that corresponds to your choice. **Use an HB pencil only**.

Example

This diploma examination is for the subject of

A. Biology
B. Physics
C. Chemistry
D. Mathematics

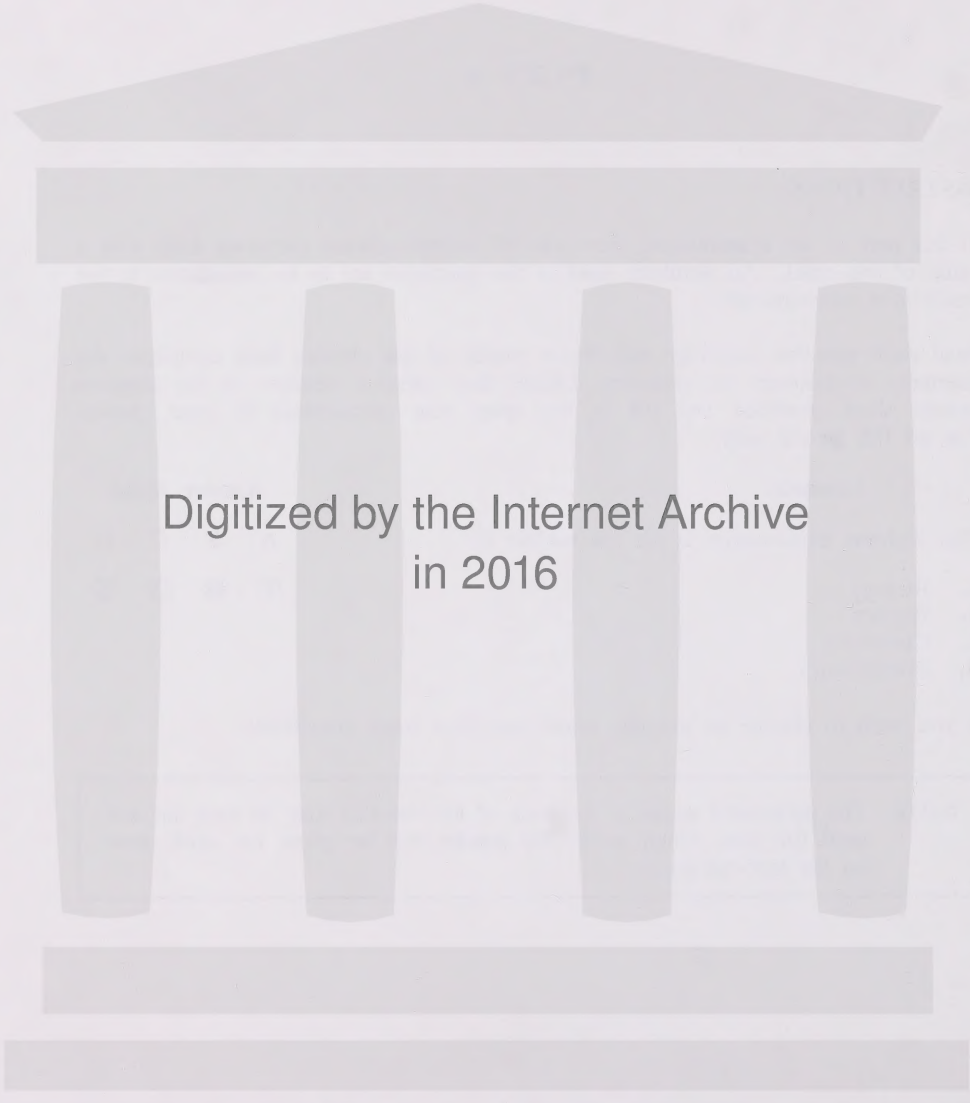
Answer Sheet

A	B	C	D
①	●	③	④

If you wish to change an answer, erase your first mark completely.

NOTE: The perforated pages at the back of this booklet may be torn out and used for your rough work. **No marks** will be given for work done on the tear-out pages.

DO NOT TURN THE PAGE TO START THE EXAMINATION UNTIL TOLD TO DO SO BY THE PRESIDING EXAMINER.



1. The angle of refraction is measured between the

   A. incident ray and the normal
   B. refracted ray and the normal
   C. refracted ray and the interface
   D. incident ray and the refracted ray

2. If the speed of light in a certain material is 2.17×10^8 m/s, the index of refraction of the material is

   A. 0.723
   B. 1.00
   C. 1.38
   D. 2.17

3. The first experimental evidence supporting the wave theory of light was provided by

   A. Young's double-slit experiment
   B. Römer's measurement of the velocity of light
   C. Hertz's discovery of electromagnetic radiation
   D. Newton's use of a prism to split white light into colors

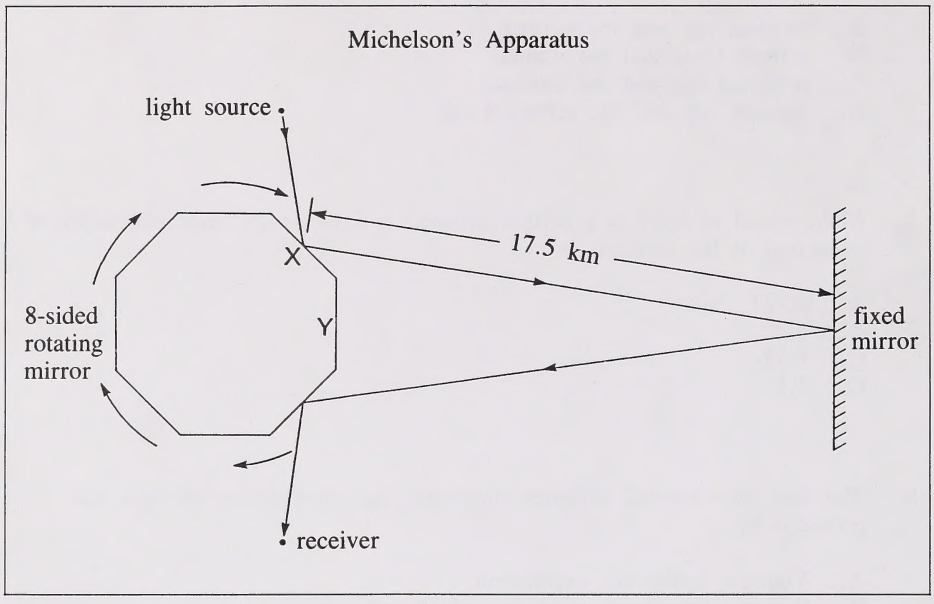
4. If light with a frequency of 5.0×10^{14} Hz passes through a diffraction grating with 2000 lines/cm, the angle from the central maximum to the second-order bright fringe is

   A. 3.5°
   B. 7.0°
   C. 14°
   D. 21°

5. When red light and green light strike the retina simultaneously, the sensation is similar to that produced by the color

   A. magenta
   B. yellow
   C. black
   D. blue

Use the following information to answer question 6.



6. At what rate must the mirror rotate so that light striking face X will return to strike face Y and be detected at the receiver?

A. 1.07×10^{3} rev/s
B. 2.14×10^{3} rev/s
C. 8.57×10^{3} rev/s
D. 1.07×10^{6} rev/s

---

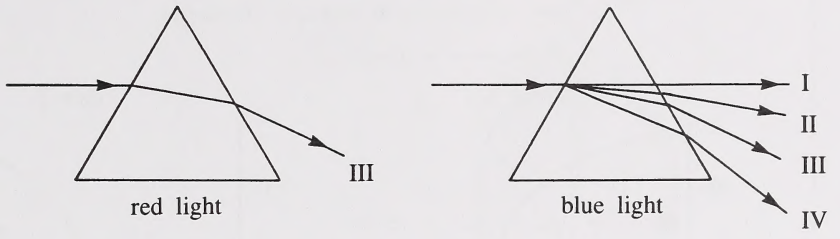
7. Light with a wavelength of 6.0×10^{-7} m passes through a double slit of separation 0.10 mm. If an interference pattern is produced on a screen that is 40.0 cm from the slits, the distance from the central maximum to the third-order bright fringe is

A. 7.2×10^{-7} m
B. 2.4×10^{-3} m
C. 7.2×10^{-3} m
D. 2.2×10^{-2} m

8. The theory that light is a transverse wave is supported by observations of the

A. polarization of light
B. absorption of light
C. dispersion of light
D. scattering of light

Use the following information to answer question 9.



Red light and blue light are incident on two identical prisms at the same angle of incidence.

9. Which ray represents the path taken by the refracted blue light?

A. I
B. II
C. III
D. IV

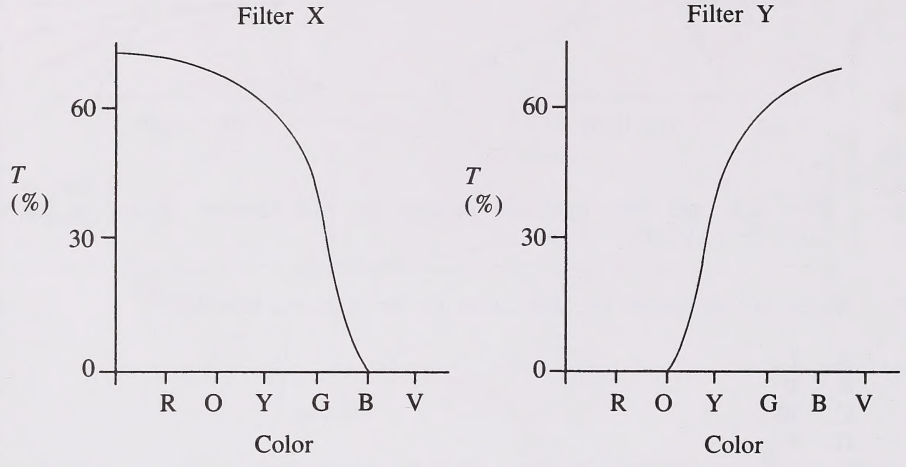
---

10. When observed through a rotating filter, the bright patches on a newly waxed floor alternately brighten and darken. This effect could be due to

A. refraction
B. diffraction
C. interference
D. polarization

Use the following information to answer question 11.

These graphs show the transmission T of light through filters X and Y.



In an experiment, a beam of white light is incident on filters X and Y. The color of the output light is recorded.

11. After passing through filters X and Y, the light is a mixture of the colors

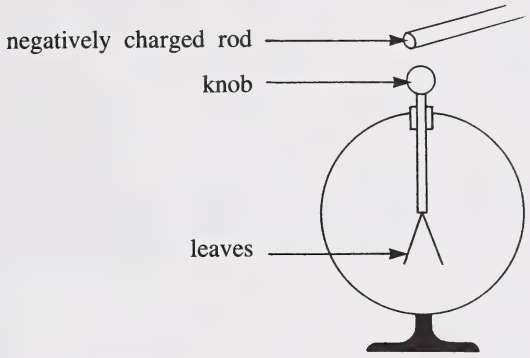
A. yellow and green
B. orange and blue
C. blue and violet
D. green and blue

---

12. Twenty protons have a total charge of

A. $+3.20 \times 10^{-18}$ C
B. $+1.60 \times 10^{-19}$ C
C. -3.20×10^{-18} C
D. -1.60×10^{-19} C

Use the following information to answer question 13.



A negatively charged rod is brought near the knob of a neutral electroscope.

13. When the negatively charged rod is close to the knob of the electroscope, the electroscope becomes charged

A. positively on both the knob and the leaves
B. negatively on both the knob and the leaves
C. positively on the knob and negatively on the leaves
D. negatively on the knob and positively on the leaves

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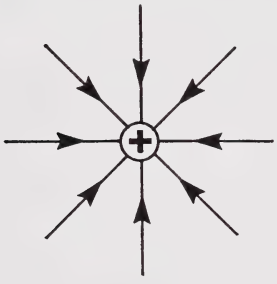
14. Which diagram could represent an electric field?

A.



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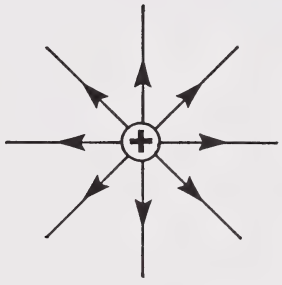
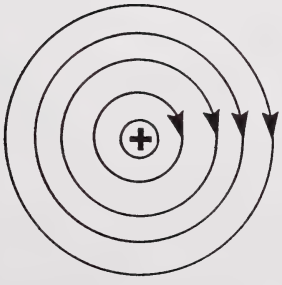


C.



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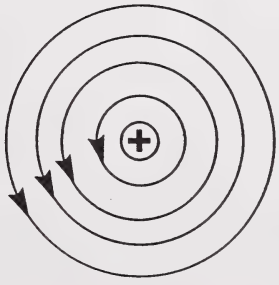


15. Free electrons in an isolated conductor can be temporarily redistributed by a nearby charged object. This redistribution of charge is called

A. induction
B. conduction
C. equalization
D. conservation

16. The force between two positive charges that are 5.0 m apart is 1.8×10^{-2} N. If one charge is twice as large as the other charge, the magnitude of the smaller charge is

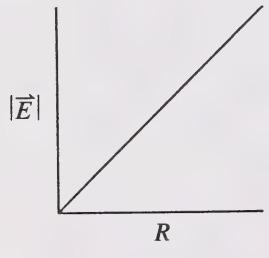
A. 2.5×10^{-11} C
B. 5.0×10^{-11} C
C. 5.0×10^{-6} C
D. 7.0×10^{-6} C

17. A planet has a mass exactly nine times that of the Earth. If an object weighs 5.0 N on Earth and 5.0×10^{2} N on the planet, then the planet radius R_p compared to the Earth radius R_e is given by

A. $R_p = 0.09R_e$
B. $R_p = 0.30R_e$
C. $R_p = 3.3R_e$
D. $R_p = 11R_e$

18. Which graph represents the electric field $|\vec{E}|$ as a function of the distance R from a point charge?

A.



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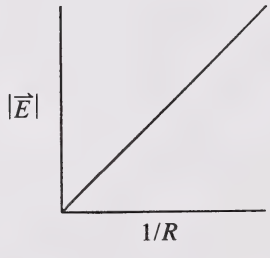

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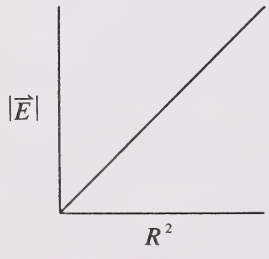

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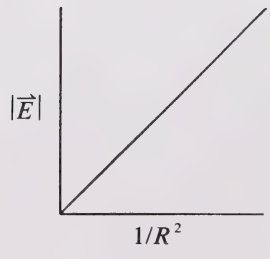


19. An electron passes between two plates that are 5.0×10^{-3} m apart and that have a potential difference of 4.0×10^{3} V between them. What is the magnitude of the force that acts on the electron?

A. 1.3×10^{-16} N
B. 6.4×10^{-16} N
C. 1.3×10^{-13} N
D. 6.4×10^{-13} N

20. In order to triple the current in a circuit with an original resistance of R, the potential difference could be doubled and the resistance

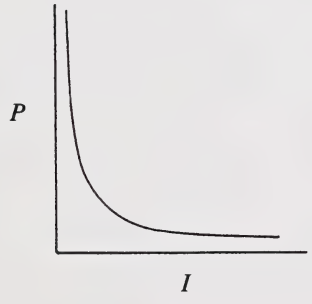
A. reduced to $2R/3$
B. reduced to $3R/4$
C. increased to $4R/3$
D. increased to $3R/2$

21. A voltaic cell transforms

A. chemical energy to electric energy
B. static charge to electric current
C. kinetic energy to electric power
D. electric energy to heat energy

22. Which graph shows the relationship between the power P dissipated by a fixed resistor R and the current I that it draws?

A.



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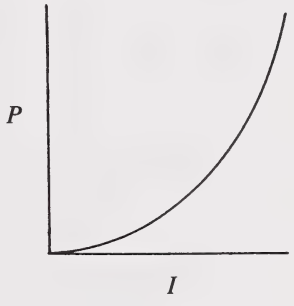

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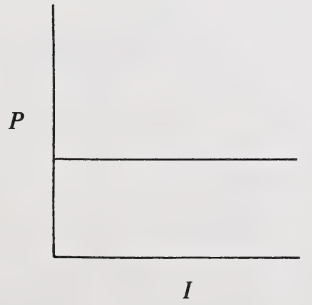

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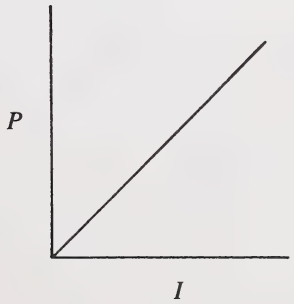


23. If an electron is accelerated through a distance of 0.20 m across a potential difference of 5.0×10^2 V, its gain in kinetic energy is

A. 5.0×10^2 J
B. 4.0×10^{-16} J
C. 8.0×10^{-17} J
D. 1.6×10^{-17} J

24. A proton and an alpha particle are accelerated by the same voltage and are projected perpendicularly through the same magnetic field. In this experiment, it follows that the two particles have the same

A. orbital direction
B. kinetic energy
C. orbital radius
D. momentum

25. Which is an example of the entrapment of charged particles by a magnetic field?

A. Electrons on charged combs
B. Protons in atomic nuclei
C. Electrons in atoms
D. Van Allen belts

26. Visible light travels at the same speed in a vacuum as do

A. X-rays
B. beta rays
C. alpha rays
D. cathode rays

27. A characteristic of electromagnetic disturbances is that they

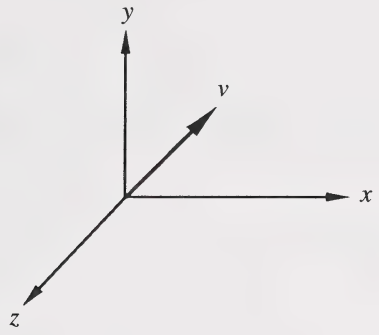
A. radiate in only two directions
B. travel only short distances before dying out
C. experience a change in frequency when they are refracted
D. consist of electric and magnetic fields that vary over time

28. If the distance from Earth to a planet is 2.0×10^{11} m, a radar signal can travel to that planet and return to Earth in

A. 6.7 min
B. 11 min
C. 13 min
D. 22 min

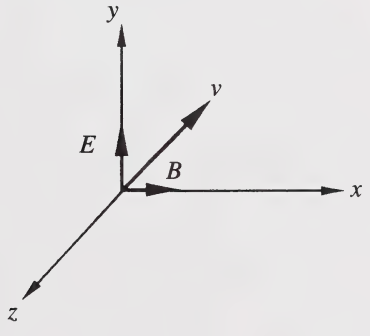
Use the following information to answer question 29.

An electromagnetic wave propagates along the z-axis as shown.

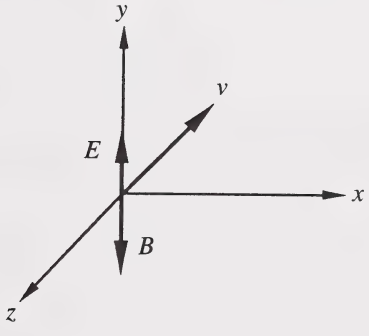


29. A correct orientation of the electric and magnetic fields of the wave is shown by

A.



B.



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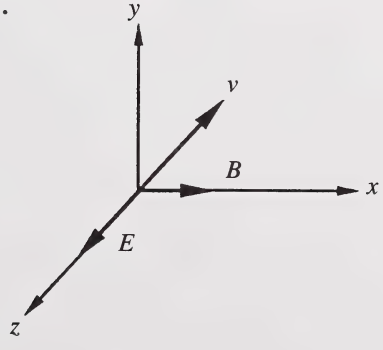

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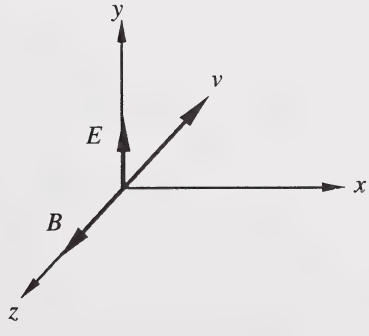
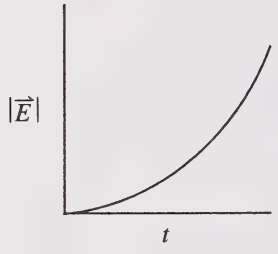


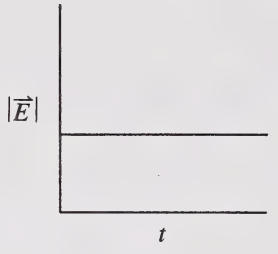
Use the following information to answer question 30.

Graphs of Electric Fields

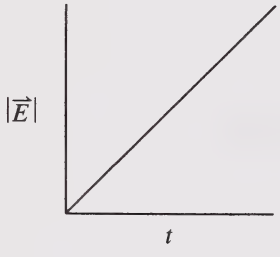
I



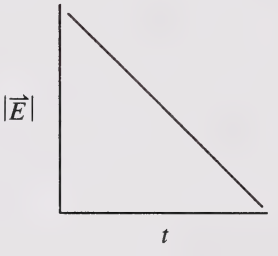
II



III



IV



The graphs show the measured value of the electric field $|\vec{E}|$ as a function of time t.

30. A particular electric field produces a zero magnetic field over a time interval. A possible graph of this electric field is

A. I
B. II
C. III
D. IV

31. The wavelength of a particular red light in a vacuum is 6.3×10^{-7} m. The period of the red light is

A. 4.8×10^{14} s
B. 1.6×10^{6} s
C. 1.9×10^{2} s
D. 2.1×10^{-15} s

32. AM radio stations measure their broadcast signals in kilohertz. The wavelength of the signal from the hypothetical radio station 620 CXXX is

A. 4.8×10^{2} m
B. 6.2×10^{2} m
C. 4.8×10^{5} m
D. 1.9×10^{11} m

Use the following information to answer question 33.

Sources of Electromagnetic Radiation

I. Unstable nuclei
II. Electrons striking a dense metal surface
III. Electrons oscillating in a wire at high frequency
IV. Bodies with a surface temperature of 6000°C

33. The order of electromagnetic radiation sources that matches a radio wave, visible light, an X-ray, and a gamma ray respectively is

A. I, II, III, IV
B. III, IV, I, II
C. III, IV, II, I
D. IV, III, II, I

---

34. The question of the ether moving relative to the motion of the observer was answered by

A. Hertz's experiment, which detected electromagnetic radiation at a distance

B. the observation that electromagnetic waves propagate through space in unending succession

C. Einstein's conjecture that the measured speed of light in free space is the same for all observers

D. the observation that the velocity of light in air is slightly less than the velocity of light in free space

35. Which quantity will **not** change when an electromagnetic wave passes from one medium to another?

A. v/λ
B. v/f
C. $f\lambda$
D. fv

36. Which hypothesis can be traced directly to one of Dalton's postulates?

A. Nuclei are positively charged.
B. The mass of an atom is concentrated in a nucleus.
C. The diameter of an atom is approximately 10^{-10} m.
D. Molecules are formed from the combination of definite numbers of atoms.

37. A student conducts a chemical analysis on a compound that contains nitrogen and oxygen only. She finds that an 8.10 g sample contains 36.4% oxygen by mass. The predicted chemical formula of this compound could be

A. NO
B. N_2O
C. NO_2
D. N_2O_3

38. When a 20.0 A current flows for 1.50 min in an electrolytic cell, 0.384 g of element X is deposited. If the atomic mass of element X is 61.8 g/mol, the combining capacity of X is

A. 1
B. 2
C. 3
D. 4

39. At what speed must an alpha particle enter perpendicularly a magnetic field of strength 0.013 T in order to form an orbit of radius 8.5 cm?

A. 2.7×10^4 m/s
B. 5.3×10^4 m/s
C. 1.1×10^5 m/s
D. 2.1×10^5 m/s

40. Electrons with a maximum kinetic energy of 3.0 eV are ejected from a metal surface by incident light with a wavelength of 1.4×10^{-7} m. The work function of this metal is

A. 3.0 eV
B. 5.9 eV
C. 8.8 eV
D. 12 eV

41. A hydrogen atom has its electron at the second energy level. The energy required to ionize this hydrogen atom is the same as the energy of a photon with a wavelength of

A. 3.65×10^{-7} m
B. 1.82×10^{-7} m
C. 1.22×10^{-7} m
D. 9.12×10^{-8} m

42. Rutherford developed a new model of the atom. The critical result from one of his experiments was that when alpha particles are fired at gold foil,

A. they can be absorbed by the gold foil
B. only a few pass through the gold foil undeflected
C. they pass through the gold foil but are spread into a broader beam
D. a small portion of the alpha particles is scattered through large angles

43. Bohr hypothesized that chemical families have similar chemical properties because each element in the family has

A. an equal number of electrons in each of its shells

B. an even number of electrons in its outermost shell

C. the same number of electrons in its outermost shell

D. exactly one more electron in its innermost shell than the element in the previous family has

44. An experimental result that supports Einstein's relativity theory is the

A. changing value of the q/m ratio of a fast electron
B. frequency change in X-rays scattered off an electron
C. bright-line spectrum produced by an incandescent gas
D. discrete energy change of an electron scattered off a gas atom

45. The formula used to determine the kinetic energy of an object moving at a speed of $0.8c$ is

A. $E_k = mc^2$

B. $E_k = \frac{1}{2}mv^2$

C. $E_k = \frac{1}{2}m_o v^2$

D. $E_k = (m - m_o)c^2$

46. By studying the results of collisions between photons and small particles, a physicist can determine experimentally that energy changes have taken place. These energy changes are detected by measuring changes in a photon's

A. angular distribution
B. wavelength
C. charge
D. speed

47. What is the de Broglie wavelength of an electron that accelerates from rest through a potential difference of 1.0×10^2 V?

A. 6.5×10^{-34} m
B. 5.4×10^{-24} m
C. 1.2×10^{-10} m
D. 5.9×10^{6} m

48. Quantum mechanics is currently accepted over other atomic theories because it provides

A. simpler calculations to determine the energy levels of atoms
B. better explanations of experimental facts
C. a visual picture of the atom
D. a simple model of the atom

49. If the speed of an alpha particle is measured to be 8.0×10^6 m/s $\pm$ 10%, the uncertainty in the position of the particle is in the order of magnitude of

A. 10^{-16} m
B. 10^{-14} m
C. 10^{-12} m
D. 10^{-10} m

YOU HAVE NOW COMPLETED PART A. PROCEED DIRECTLY TO PART B.

PART B

INSTRUCTIONS

In this part of the examination, there are four written-response questions for a total of 21 marks. All numbers used in the questions are to be considered as the result of a measurement.

Write your solutions in the examination booklet as neatly as possible.

Your solutions **must show all** pertinent explanations, calculations, and formulas. Full marks will be assigned **only** to those solutions that **show** all pertinent explanations, calculations, and formulas.

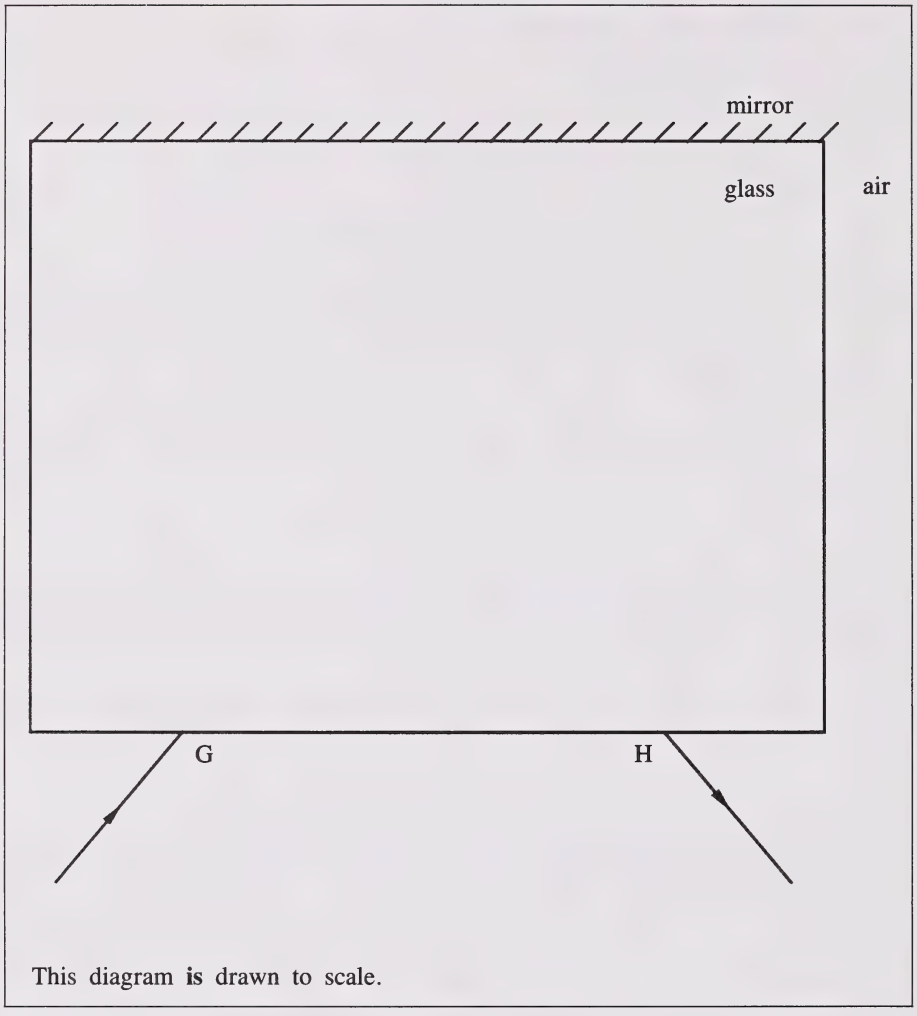
All numerical answers must be given correct to the appropriate number of significant digits.

NOTE: The perforated pages at the back of this booklet may be torn out and used for your rough work. **No marks** will be given for work done on the tear-out pages.

START PART B IMMEDIATELY.

FOR DEPARTMENT USE ONLY

Use the following diagram to answer question 1.



This diagram **is** drawn to scale.

(5 marks)

1. Light is incident on a rectangular piece of glass at point G, reflects from a mirror, and then emerges from the glass at point H, as shown.

a. On the diagram, draw an accurate path of the ray within the glass.

FOR DEPARTMENT USE ONLY

b. Using an accurate ruler, make appropriate **length** measurements, indicate them on the diagram, and then use these length measurements to determine the index of refraction of the glass. If you do not have an accurate ruler, there is a ruler provided on each of the tear-out pages.

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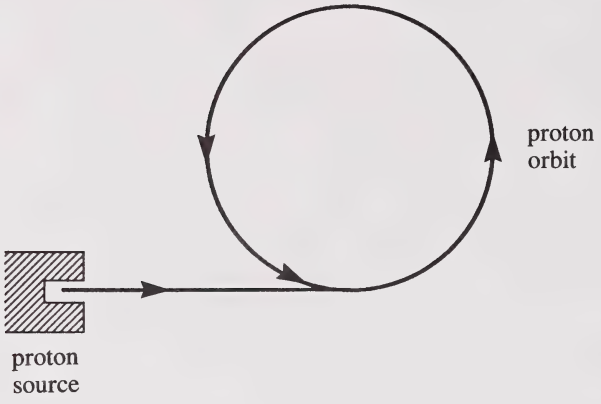
Use the following information to answer question 2.



A magnetic field may be calculated by measuring the orbit radius and orbit time of a proton in the field. The velocity of the proton is in the plane of the paper.

2. In a particular field, the orbit radius is 0.970 m and the orbit time is 2.80×10^{-7} s.

(2 marks)

a. Determine the speed of the proton in its orbit.

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b. Determine the magnitude of the magnetic field.
(If you were unable to calculate the speed in part a., use the hypothetical value $v = 2.55 \times 10^7$ m/s.)

(2 marks)

c. What is the direction of the external magnetic field?

(1 mark)

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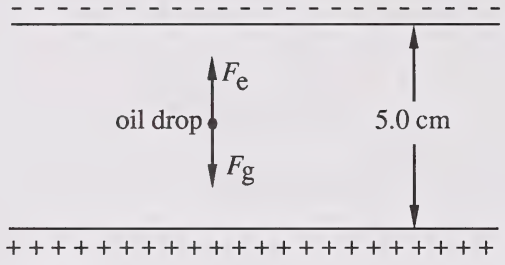
(6 marks)

Use the following information to answer question 3.

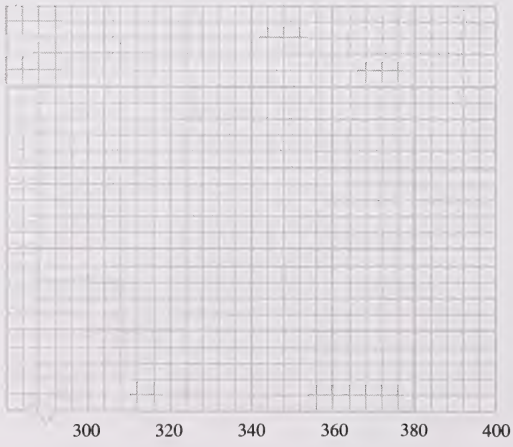
A student placed an oil drop of mass 4.0×10^{-16} kg and charge q between two parallel plates 5.0 cm apart. The student then caused the drop to accelerate vertically upward at different rates by varying the potential difference between the plates.



The student's data are summarized in the table:

Potential Difference (V)	Acceleration (m/s^2)
300	4.8
320	5.6
340	6.4
360	7.4
380	8.2
400	9.0

3. a. Using the grid provided, plot a graph of acceleration as a function of potential difference.



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b. Determine the slope of the graph.

c. Use a suitable averaging procedure to determine the charge q of the oil drop.

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(5 marks)

4. An alpha particle is accelerated from rest through a potential difference of 2.54×10^9 V. Determine the speed reached by the particle. Justify the formulas used in your solution.

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Justification of formulas:

_____

_____

_____

_____

_____

YOU HAVE NOW COMPLETED THE EXAMINATION. IF YOU HAVE TIME, YOU MAY WISH TO GO BACK AND CHECK YOUR ANSWERS.

TEAR-OUT PAGE

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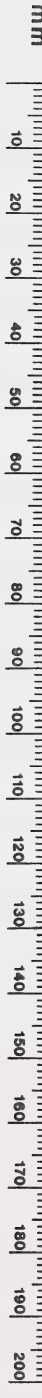

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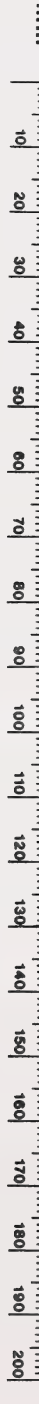

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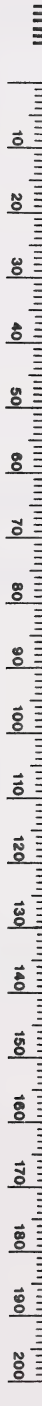

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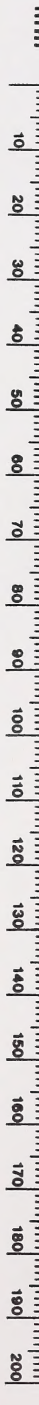

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M1 M2 M3 M4

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